

# Association of body mass index and age as risk factors for post-anesthetic shivering in mastectomy patients under general anesthesia in East Java, Indonesia

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## ABSTRACT

Intraoperative hypothermia and post-anesthetic shivering (PAS) remain frequent complications in oncologic surgery under general anesthesia, yet evidence integrating intraoperative temperature changes with PAS severity in mastectomy patients is limited. This study aimed to evaluate intraoperative temperature profiles, determine the incidence and severity of PAS, and analyze the association between age, body mass index (BMI), and PAS among radical mastectomy patients. A cross-sectional observational study was conducted involving 36 women undergoing radical mastectomy with endotracheal general anesthesia. Core temperature was measured at 30 and 60 minutes intraoperatively, and PAS was assessed using the bedside shivering assessment scale (BSAS) upon admission to the recovery room. Moderate intraoperative hypothermia was observed in 72.2% of patients at 60 minutes, while PAS occurred in 30.6% of cases. Significant associations were identified between PAS and BMI ( $p = 0.001$ ), as well as age ( $p = 0.026$ ). Moderate-to-severe shivering (BSAS scores 2-3) was more frequently observed among underweight and elderly patients. This study provides novel evidence by linking intraoperative hypothermia patterns with PAS severity using BSAS in mastectomy patients. Clinically, the findings support structured perioperative temperature monitoring and the implementation of risk-based warming protocols, particularly for patients with low BMI and advanced age.

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## 1. INTRODUCTION

Post-anesthetic shivering (PAS) is a common postoperative complication that occurs across a wide range of surgical procedures and anesthetic techniques. Clinically, PAS is not merely a source of discomfort but is associated with increased oxygen consumption, elevated carbon dioxide production, metabolic acidosis, and heightened cardiovascular workload, which may compromise postoperative recovery, particularly in vulnerable patients [1]-[4]. As a result, PAS is increasingly recognized as an indicator of inadequate perioperative thermal regulation rather than a benign postoperative event.

Perioperative hypothermia remains the most consistently reported trigger of PAS. Hypothermia during anesthesia arises from impaired thermoregulatory control, anesthetic-induced vasodilation, exposure to cold operating room environments, and heat loss from large surgical fields [5]-[7]. Despite advances in

active warming technologies and international recommendations advocating routine temperature monitoring, inadvertent perioperative hypothermia continues to be reported at high rates, especially during major oncologic surgeries [6]–[9]. These findings suggest a persistent gap between guideline recommendations and real-world clinical practice.

Several patient-related factors have been identified as contributors to perioperative hypothermia and PAS. A recent meta-analysis by Tan *et al.* [10] demonstrated that low body mass index (BMI), advanced age, prolonged surgical duration, and extensive fluid administration significantly increase the risk of postoperative hypothermia. Among these factors, BMI is particularly relevant because it reflects the patient's thermal insulation capacity and energy reserve. Underweight patients possess reduced subcutaneous fat, leading to accelerated heat loss, while age-related physiological changes further impair thermoregulatory responses [11], [12]. However, the relative contribution of BMI and age to PAS remains inconsistently reported across studies, with some investigations suggesting a higher PAS risk in overweight populations, highlighting the complexity of thermoregulation during anesthesia [13], [14].

Importantly, existing studies vary considerably in their methodological approaches. Many investigations focus primarily on postoperative temperature measurements or single time-point assessments, limiting insight into intraoperative temperature dynamics [15], [16]. Others examine heterogeneous surgical populations, making it difficult to extrapolate findings to specific procedures such as mastectomy, which is characterized by prolonged operative time, extensive tissue exposure, and substantial heat loss [11]. Consequently, there is limited empirical evidence linking structured intraoperative temperature trends with PAS in breast cancer surgery.

The scarcity of data is even more pronounced in low- and middle-income countries, including Indonesia, where resource constraints may limit routine use of active warming systems. Most published evidence originates from high-resource settings, and few studies have examined PAS risk factors within Indonesian surgical contexts, particularly using structured intraoperative temperature measurements and standardized shivering assessment tools. As a result, local evidence to inform risk-based perioperative thermal management remains insufficient.

Therefore, this study aimed to analyze intraoperative temperature changes at defined intervals and to evaluate the association between body mass index, age, and post-anesthetic shivering among mastectomy patients undergoing general anesthesia in an Indonesian tertiary care setting. The study integrates patient-related risk factors with intraoperative thermal trends. It seeks to address an important gap in the literature and to provide context-specific evidence that may support the development of structured perioperative warming strategies, particularly for high-risk patient groups.

## 2. METHOD

This descriptive observational study was conducted at a military tertiary hospital in Malang, East Java, Indonesia, involving women undergoing radical mastectomy under general anesthesia with endotracheal intubation. A purposive sampling approach was applied to obtain a homogeneous clinical population, resulting in 36 eligible participants. Inclusion criteria comprised ASA physical status III, surgical duration exceeding 60 minutes, exposure to low operating room temperature, absence of pharmacological anti-shivering agents, and provision of written informed consent. Patients with ASA IV status or postoperative complications requiring intensive care admission were excluded to minimize confounding effects on thermoregulation.

Intraoperative body temperature was measured using a calibrated infrared thermometer at fixed time points, specifically 30 and 60 minutes after induction of anesthesia. PAS was assessed upon arrival in the recovery room using the bedside shivering assessment scale (BSAS), a clinically validated instrument with established reliability and inter-rater consistency in postoperative settings. BMI was classified according to World Health Organization criteria into underweight ( $<18.5$  kg/m<sup>2</sup>), normal (18.5–24.9 kg/m<sup>2</sup>), and overweight ( $\geq 25$  kg/m<sup>2</sup>), while age was categorized into adult (20–60 years) and elderly ( $>60$  years). Hypothermia severity was defined using standard clinical thresholds.

To reduce variability from factors influencing hypothermia, all patients received anesthesia according to the hospital's standardized protocol, and no active warming devices were used during surgery. Operating room conditions and intraoperative fluid management followed routine institutional practice for all cases. Descriptive statistics were used to summarize patient characteristics, and associations between PAS and categorical variables (BMI and age) were analyzed using Chi-square tests with a significance level set at  $p < 0.05$ . Ethical approval was obtained before study initiation, and all procedures complied with the Declaration of Helsinki.

### 3. RESULTS AND DISCUSSION

The study comprised 36 women undergoing radical mastectomy under general anesthesia with endotracheal intubation. Intraoperative temperature monitoring demonstrated a progressive decline during surgery. At 30 minutes, 19 patients (52.8%) had already developed moderate hypothermia, while this proportion increased to 26 patients (72.2%) at 60 minutes. No cases of severe hypothermia (<32 °C) were observed during the intraoperative period.

Table 1 summarizes patient characteristics and intraoperative temperature profiles. Most participants were adults aged 20–60 years (77.8%), while elderly patients (>60 years) accounted for 22.2% of the sample. Nearly half of the patients (47.2%) were classified as underweight based on body mass index (BMI). At 60 minutes intraoperatively, moderate hypothermia was observed in the majority of patients (72.2%), indicating substantial intraoperative heat loss. PAS was observed in 11 patients (30.6%), while 25 patients (69.4%) did not experience shivering. PAS was assessed using the BSAS upon admission to the recovery room.

The Chi-square analysis presented in Table 2 demonstrated statistically significant associations between PAS and BMI ( $\chi^2 = 14.516$ ;  $df = 2$ ;  $p = 0.001$ ), as well as between PAS and age ( $\chi^2 = 4.946$ ;  $df = 1$ ;  $p = 0.026$ ). Elderly patients and those with lower BMI were more likely to develop PAS compared to adult and normal-weight patients. Among the 11 patients who developed PAS, BSAS scores ranged from 1 to 3. Mild shivering (BSAS score 1) was observed in 4 patients (11.1%), moderate shivering (BSAS score 2) in 5 patients (13.9%), and severe shivering (BSAS score 3) in 2 patients (5.6%). No cases of generalized incapacitating shivering were recorded.

Table 1. Summarizes patient characteristics and intraoperative temperature profiles (n = 36)

| Variable                   | Category                    | Frequency (n) | Percentage (%) |
|----------------------------|-----------------------------|---------------|----------------|
| Age                        | Adult (20-60 years)         | 28            | 77.8           |
|                            | Elderly (>60 years)         | 8             | 22.2           |
| Body mass index (BMI)      | <18.5 (Underweight)         | 17            | 47.2           |
|                            | 18.5-25.0 (normal)          | 19            | 52.8           |
|                            | >25.0 (overweight)          | 4             | 11.1           |
| Intraoperative temperature | 30 min-Mild hypothermia     | 17            | 47.2           |
|                            | 30 min-Moderate hypothermia | 19            | 52.8           |
|                            | 60 min-Mild hypothermia     | 10            | 27.8           |
|                            | 60 min-Moderate hypothermia | 26            | 72.2           |
|                            | Severe hypothermia (<32 °C) | 0             | 0              |
| Shivering incidence        | Yes                         | 11            | 30.6           |
|                            | No                          | 25            | 69.4           |

Table 2. Chi-square test results for age and BMI to PAS

| Variable | Pearson Chi-square | df | p-value |
|----------|--------------------|----|---------|
| Age      | 4.946              | 1  | 0.026   |
| BMI      | 14.516             | 2  | 0.001   |

### 4. DISCUSSION

This study demonstrated a high incidence of intraoperative hypothermia among patients undergoing radical mastectomy under general anesthesia, with more than two-thirds of participants developing moderate hypothermia by 60 minutes intraoperatively. These findings indicate that clinically relevant heat loss occurs early during surgery despite standardized anesthetic management. Similar patterns of intraoperative hypothermia have been reported in major oncologic procedures, particularly in the absence of routine active warming strategies [17], [18].

Post-anesthetic shivering occurred in nearly one-third of patients, and statistically significant associations were identified between PAS and both age and BMI. Elderly patients and those with low BMI were significantly more likely to experience PAS, highlighting the importance of patient-related factors in postoperative thermoregulatory disturbances. These findings are consistent with previous studies reporting increased PAS susceptibility among elderly patients due to age-related declines in thermoregulatory capacity, including impaired vasoconstriction and reduced shivering thresholds [13], [19], [20]

The association between low BMI and PAS observed in this study supports prior evidence suggesting that underweight patients have limited thermal insulation and reduced metabolic reserves, predisposing them to hypothermia and subsequent shivering [10]. However, conflicting findings have been reported in the literature, with some studies identifying higher PAS risk among overweight patients [13]. This discrepancy suggests that BMI alone does not determine PAS risk but likely interacts with other perioperative factors. Beyond PAS incidence, shivering severity assessed using BSAS revealed that moderate-to-severe shivering (scores 2-3) was more frequently observed among elderly and underweight

patients. Although inferential testing for BSAS severity was not conducted due to sample size limitations, this descriptive pattern suggests that vulnerable patient groups may experience not only a higher occurrence but also greater intensity of PAS, increasing the clinical burden during postoperative recovery.

The high incidence of moderate hypothermia at 60 minutes further emphasizes the vulnerability of mastectomy patients to intraoperative heat loss. Current perioperative guidelines recommend continuous temperature monitoring and the use of active warming strategies, particularly in high-risk populations [21], [22]. The concurrent occurrence of hypothermia and PAS observed in this study supports the clinical relevance of early thermal interventions such as prewarming and forced-air warming systems, as demonstrated in previous studies [23], [24].

Several limitations should be considered when interpreting these findings. The relatively small sample size limits statistical power and restricts more advanced multivariable or severity-based analyses, thereby limiting causal inference. Additionally, this single-center study was conducted in a specific surgical setting, which may reduce the generalizability of the results to other institutions with different patient populations or perioperative practices. Intraoperative temperature measurements were limited to two time points (30 and 60 minutes), potentially overlooking dynamic temperature fluctuations throughout surgery. Moreover, other known factors influencing PAS, such as ASA physical status, anesthetic technique, surgical duration, and environmental conditions, were not analyzed and may act as confounders [17], [25]-[30].

Despite these limitations, the use of standardized temperature monitoring, validated PAS assessment tools, and appropriate statistical analysis strengthens the internal validity of this study. These methodological approaches contribute to the reliability of the study findings and support the accuracy of the results obtained. While generalization should be undertaken cautiously, the findings provide context-specific evidence supporting risk-based perioperative warming strategies and structured temperature monitoring in mastectomy patients, particularly within similar clinical settings.

## 5. CONCLUSION

This study demonstrates a high incidence of intraoperative hypothermia among patients undergoing radical mastectomy under general anesthesia, with more than two-thirds of patients developing moderate hypothermia within the first 60 minutes of surgery. Post-anesthetic shivering occurred in nearly one-third of patients and was significantly associated with advanced age and low body mass index, indicating that patient-related factors play an important role in postoperative thermoregulatory disturbances. Beyond PAS incidence, the descriptive distribution of BSAS scores suggests that underweight and elderly patients may experience greater shivering severity, highlighting an increased clinical burden in these vulnerable groups. Although causal relationships cannot be inferred, these findings underscore the clinical relevance of identifying high-risk patients prior to surgery.

From a clinical perspective, the results support the implementation of structured perioperative temperature monitoring and targeted warming protocols, particularly for patients with low BMI and advanced age. Early thermal interventions, such as prewarming and active intraoperative warming, may reduce the incidence and severity of post-anesthetic shivering and improve postoperative comfort and safety. In settings where universal warming is not feasible, risk-based thermal management represents a pragmatic approach to improving perioperative care quality.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review &amp; Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

## CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

## DATA AVAILABILITY

Due to institutional confidentiality rules, the study data are not publicly available. However, the datasets may be requested from the corresponding author in writing and will be provided pending institutional approval.

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